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A BIOGEOGRAPHICALLY BASED ASSESSMENT OF THE POTENTIAL MAYFLY FAUNA OF NEVADA

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Abstract.—A faunal assessment of the mayflies of Nevada is in progress. We hypothesize the number and composition of species and genera expected for Nevada based on the known biographical distribution of western species. Sixteen species and 12 genera are presently known from Nevada, but we hypothesize the total number of species and genera will be 74 and 32, respectively. Biogeographical patterns reveal where in the state species should be found.

Key Words.—Insecta, mayflies, Nevada, geographic distribution, biogeography, Ephemeroptera

The mayflies (Ephemeroptera) of North and Central America are now well known and the species composition of only a few areas on the continent are poorly reported. The most poorly known region of the Nearctic is Nevada, where only 15 species have been reported. Mayflies of most states surrounding Nevada (Arizona, California, Idaho, Oregon and Utah) had been thoroughly studied. Much of this literature is scattered in many individual papers, but some summary references include Allen & Edmunds (1956) for Oregon, Day (1956) for California, Edmunds (1954) for Utah, Edmunds et al. (1976) and Edmunds (1984) for North America, Jensen (1966) for Idaho and Kilgore & Allen (1973) for Arizona. We predict the potential mayfly fauna for Nevada based upon the biogeographic distribution of species in western North America. Allen (1990) has published the distribution patterns of North and Central American mayflies; we refer to his distribution patterns in this paper.

Collections of Nevada mayflies are now in progress to corroborate our hypothesis and also to extend the distributional range and limits of western North American species.

Physiography of Nevada.—Nevada is a large state which has been poorly collected. The state is about 790 km long and 512 km wide. Drainage from the southeastern corner of Nevada is to the Gulf of California via the Colorado River, but most of the remainder of the state lies within The Great Basin. This is a geographic/hydrologic region where no surface water leaves except by evaporation. The usage of the term "Great Basin" has been confused at times by biologists and anthropologists (Fiero 1986). The Great Basin lies in the northern part of a much larger geologic province called the Basin and Range. A bird's eye view of Nevada would see many uplifted blocks (horsts) forming the mountain ranges separated by broad elongated valleys or basins formed by down dropped blocks (grabens). The long axes of the valleys and ranges generally trend north-south. The valley floors are quite high, generally between 1200 and 1500 m above sea level. The mountains may be 3900 m high (Fiero 1986).

Lentic habitats dominated the landscape during former pluvial periods (Hubbs & Miller 1948), but these ecosystems are relatively uncommon today compared

to the many lotic systems present. Two important river systems include the Humboldt River in northern Nevada and the Colorado River in southern Nevada but the latter has been largely transformed into a lentic habitat (Lake Mead). There are some smaller rivers, but these are overshadowed in number by the numerous small streams that flow down the mountain canyons. Few of these can be seen from the basin highways and many are difficult to get to, often requiring high clearance vehicles and/or four wheel drive. As a result, it may be a long time before we have an accurate picture of the aquatic insect fauna of the state.

Mayfly Distribution Patterns.—The distributions of mayflies suggest that North and Central America can be divided into five biogeographic subdivisions with regard to Ephemeroptera (Allen 1990): Arctic, Northern American, Western North American, Eastern North American, and Mesoamerican. The "Arctic Subdivision" includes species that are distributed about 58° North Latitude. The "North American Subdivision" includes species that are widely distributed in all of North America. The "Eastern North American Subdivision" includes species that are restricted to western or eastern North America in Mexico, the United States, and Canada. The "Mesoamerican Subdivision" includes species that are distributed mainly in tropical Mexico and Central America, but may occur as far north as the southern U.S.

North American Subdivision

This subdivision includes two distinct distribution patterns, the "Pancontinental" and the "Widespread North American." Both patterns include species known in Nevada, and species expected there.

Pancontinental Distribution Pattern.—Ten species occur across North America, except in the southwest deserts of the U.S. *Stenonema terminatum* (Walsh) is now known from Elko Co., *Caenis latipennis* Banks, which is presently known from only western Oregon and Washington, is not expected to occur in Nevada. *Baetis hageni* Eaton and *B. tricaudatus* Dodds eventually should be found widely distributed in the state. *Attenella margarita* (Needham), *Caenis simulans* McDonnough, *Ephemera simulans* Walker, and *Hexagenia limbata* (Serville) should be found in the northern parts of the state. *Ephemerella aurivillii* Bengtsson and *Paraleptophlebia debilis* (Walker) should be found in the western and northern parts of Nevada.

Widespread North American Distribution Pattern.—Four species are widely distributed in the United States and Canada, but have narrower distributional limits than the pancontinental species. These species are also absent from the southwest deserts. *Ephoron album* (Say) and *Heptagenia elegantula* (Eaton) are presently known in Nevada. *Baetis quilleri* Dodds, which has been reported from California, Arizona, Utah and Idaho, should be found in Nevada. *Pseudiron centralis* McDunnough is known from only southern Canada, eastern Utah and Wyoming, and the species is not expected in Nevada.

Western North American Subdivision

This subdivision includes nine distribution patterns which include species that are presently known to occur in Nevada, and/or expected to occur in the state.

Widespread Western Distribution Pattern.—This pattern (Fig. 1) includes seven species, of which six are known in Nevada: *Drunella* (*Myllonella*) *coloradensis*

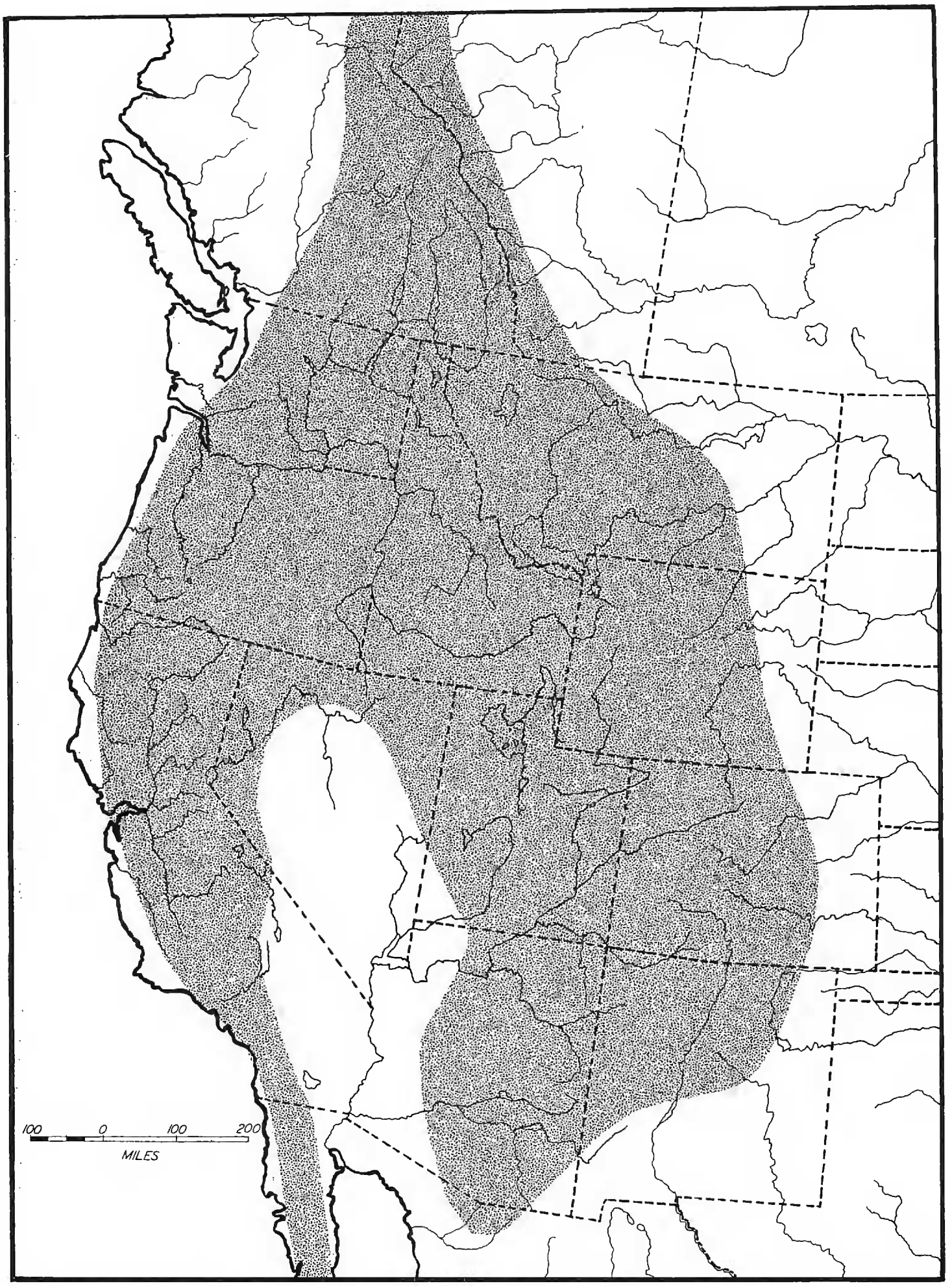

Figure 1. Composite pattern for the following mayfly distributions: *Widespread Western* (southeastern Alaska, southern Yukon Territory, western Northwest Territories, British Columbia, parts of southwestern Alberta, Washington, most of Oregon, eastern California except for southern desert, Idaho, western Montana, Wyoming, western Colorado, and New Mexico, eastern Arizona, northeastern and northwestern Nevada, and most of Utah), *Western United States* (Washington, Oregon, and California, south to near Los Angeles, northern Nevada, most of Idaho, western Montana, Wyoming, Colorado and New Mexico, eastern Arizona and most of Utah, southern British Columbia and southwestern Alberta), *Northwest and Coast Ranges* (Washington, Oregon, most of California south to about

(Dodds), *D.* (*Eatonella*) *doddsi* Needham, *D.* (*Drunella*) *grandis* (Eaton), *Ephemerella inermis* Eaton, *Iron longimanus* (Eaton), and *Tricorythodes* (*Tricorythodes*) *minutus* Traver. The distribution of *Baetis bicaudatus* Dodds (California, Idaho, Oregon, and Utah) suggests it will eventually be found in Nevada.

Western United States Distribution Pattern.—This (Fig. 1) is composed of eight species with four known from Nevada: *Rhithrogena hageni* Eaton, *R. morrisoni* (Banks), *Serratella tibialis* (McDunnough), and *Timpanoga hecuba* Eaton, are presently known from Nevada. *Baetis insignificans* McDunnough and *Paraleptophlebia memorialis* (Eaton) occur in all of the western states surrounding Nevada, and *Ephemerella infrequens* McDunnough and *Iron albertae* McDunnough occur in all of the surrounding states except Arizona. Eventually, all of these species are expected to be found in Nevada.

Northwest Distribution Pattern.—This (Fig. 2) includes 71 species, none of which are known in Nevada. As the name suggests, all species are distributed in the northern reaches of western North America. Four are known to occur in southern Idaho and Oregon and should occur in Nevada: *Choroterpes albiannulatus* McDunnough, *Paraleptophlebia heteronea* (McDunnough), *Rhithrogena futilis* (McDunnough), and *Dactylobaetis cepheus* Traver & Edmunds.

Southwest Distribution Pattern.—This (Fig. 2) includes 42 species from the southwest deserts to west-central Mexico. It is impossible to hypothesize which of these species will eventually be found in Nevada. Only three species of *Leptohyphes* (*L. apache* Allen, *L. packeri* Allen, and *L. quercus* Allen) are possible contenders, because they occur in central Arizona. *Leptohyphes apache* also occurs in the southwest corner of Utah.

Coast Ranges Distribution Pattern.—This (Fig. 3) includes 46 described species, of which two, *Baetis parallelus* Banks and *Ephemerella rama* Allen, were described from Nevada. Fourteen of the other 44 species, all of which are presently known from the Sierra Nevada Mountains in California, are expected to be found, eventually, in western Nevada: *Ameletus amador* Mayo, *Attenella delantala* (Mayo), *Baetis palisadi* Mayo, *Cinygmula tioga* Mayo, *Edmundsius agilis* Day, *Eurylophella lodi* (Mayo), *Iron dulciana* (McDunnough), *I. lepidus* (Traver), *Paracloeodes abditus* Day, *Paraleptophlebia placeri* Mayo, *Serratella levis* (Day), *S. sequoia* (Allen & Collins), *S. velmae* (Allen & Edmunds), and *Siphlonurus spectabilis* Traver. The remaining species are not expected to occur in Nevada and are known only from the coast ranges of the Pacific.

Rocky Mountain Distribution Pattern.—This (Fig. 3) is composed of 11 species, and only *Heptagenia solitaria* (McDunnough) is expected in Nevada. This species is known as far west as southern Oregon. The other species are widely distributed in the Rocky Mountains from New Mexico to Canada, but do not occur west of eastern Utah.

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half of Baja California, Idaho, western Montana, northwestern Wyoming, southeastern British Columbia and southwestern Alberta), and the *Northwest and Rocky Mountain* (western Northwest Territories south, through eastern British Columbia and western Alberta, Oregon, northern California and eastern Washington, Idaho, western Montana, Wyoming, Colorado and New Mexico, very northern Mexico, eastern Arizona and northern and eastern Utah).

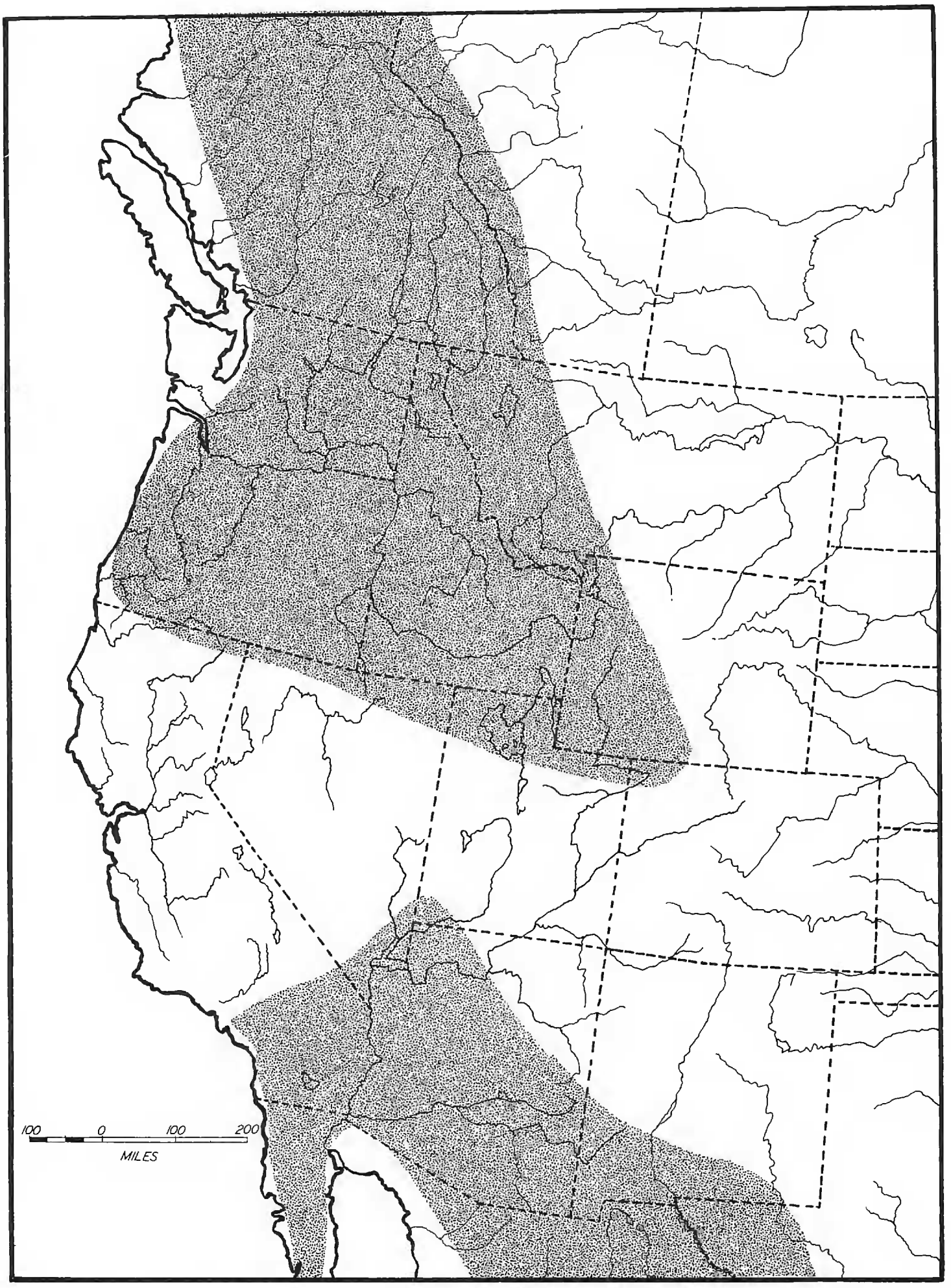

Figure 2. Composite patterns for the following mayfly distributions: *Northwest* (Washington, Oregon, Idaho, western Montana and Wyoming, northern Nevada, Utah, and northwestern Colorado, British Columbia, western Alberta and Northwest Territories), *Southwest* (Southern California and Nevada, Arizona, southern New Mexico, Baja Mexico and northwestern Mexico), *Widespread Mesoamerican* (southeastern Arizona, western New Mexico, western Mexico, most of Central America to South America, eastern Mexico into south central Texas).

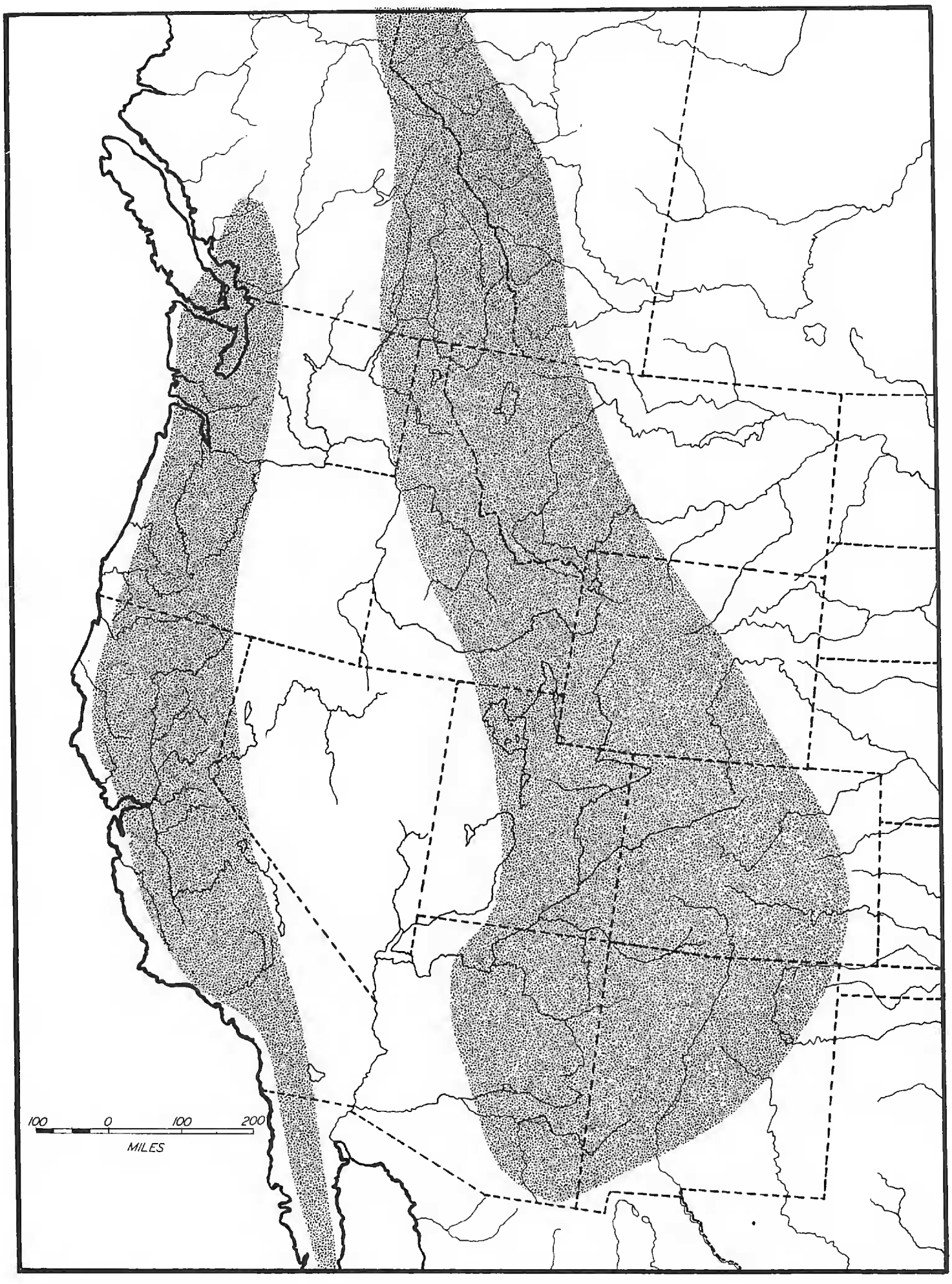

Figure 3. Composite patterns for the following mayfly distributions: *Coast Ranges* (western Washington and Oregon and California south to near Los Angeles, part of central western tip of Nevada, southwestern British Columbia), *Rocky Mountain* (western Northwest Territories, Alberta, Montana, Wyoming, Colorado, and New Mexico, eastern British Columbia, Washington, Idaho, Utah and Arizona), and *Disjunct Western* (southwestern Washington and Oregon, California south to most of Baja California, parts of central and southeastern Arizona, central New Mexico, most of Colorado, Wyoming and parts of central Montana into southwestern Alberta).

Table 1. List of the mayflies currently reported from Nevada.

Family	Species	Locality
Baetidae	*Baetis parallelus* Banks	Reno (Type Locality)
Ephemerellidae	*Drunella* (*Myllonella*) *coloradensis* (Dodds)	Elko Co., Washoe Co.
	Drunella (*Eatonella*) *doddsi* Needham	Elko Co., Washoe Co.
	Drunella (*Drunella*) *grandis* (Eaton)	Elko Co., Washoe Co.
	Ephemerella inermis Eaton	Elko Co.
	Ephemerella rama Allen	Reno (Type Locality)
	Serratella tibialis (McDunnough)	Elko Co.
	Timpanoga hecuba (Needham)	Carson River
Heptageniidae	*Heptagenia elegantula* (Eaton)	Reno
	Iron longimanus (Eaton)	Washoe Co.
	Rhithrogena hageni Eaton	Reno
	Rhithrogena morrisoni (Banks)	Reno
	Stenonema terminatum (Walsh)	Elko Co.
Oligoneuridae	*Isonychia intermedia*	Clark Co. Moapa River (unpublished)
Palingeniidae	*Ephoron album* (Say)	Elko Co.
Tricorythidae	*Tricorythodes* (*Tricorythodes*) *minutus* Traver	Elko Co.

Northwest and Coast Ranges Distribution Pattern.—This (Fig. 1) also includes 11 species, and two, *Ametropus ammophilus* Allen & Edmunds, and *Centroptilum conturbatum* McDunnough, are not expected in Nevada; their known distribution is from the coast ranges in the U.S. and Canada. The following species are known to occur in the Sierra Nevada of California and should eventually be found in the western part of Nevada: *Ameletus validus* (McDunnough), *Caudatella heterocaudata* (McDunnough), *C. hystrix* (Traver), *Drunella* (*Myllonella*) *flavilinea* (McDunnough), *Drunella* (*Drunella*) *spinifera* (Needham), *Ironodes nitidus* (Eaton), *Ironopsis grandis* (McDunnough), *Serratella teresa* (Traver), and *Siphlonurus columbianus* McDunnough.

Northwest and Rocky Mountain Pattern.—This (Fig. 1) includes eight species distributed within its geographical limits, and all of them are expected in Nevada. Five species, *Callibaetis coloradensis* Banks, *Iron deceptivus* (McDunnough), *Nixe* (*Akkarrion*) *criddlei* (McDunnough), *Rhithrogena undulata* (McDunnough), and *Siphlonurus occidentalis* Eaton, occur in southern Idaho and southern Oregon. *Callibaetis nigritus* Banks is known from southern Idaho, but not from Oregon, and *Nixe* (*Akkarion*) *simplicioides* (McDunnough) occurs in southern Idaho and northern Oregon. *Traverella albertana* (McDunnough) occurs in southern Idaho and also north central Arizona, and southeastern Utah. *Siphlonurus occidentalis* also occurs in northern California, Utah and central Arizona.

Disjunct Western Distribution Pattern.—This (Fig. 3) presently includes six species, of which four, *Cinygmula par* (Eaton), *C. mimus* (Eaton), *Rhithrogena flavianula* (McDunnough) and *Serratella micheneri* (Traver), occur in the Sierra Nevada of California. These species should eventually be found in western Nevada. *Baetis adonis* Traver, known from New Mexico and southern California, and *Tricorythodes* (*Homoleptohyphes*) *dimorphus* Allen, known from eastern Arizona and southern California, are not expected in Nevada.

Table 2. List of the mayflies predicted to be collected in Nevada.

Family	Species	Area of State
Baetidae	*Baetis bicaudatus* Dodds	Widespread
	Baetis hageni Eaton	Widespread
	Baetis insignificans McDunnough	Widespread
	Baetis palisadi Mayo	Western
	Baetis quilleri Dodds	Widespread
	Baetis tricaudatus Dodds	Widespread
	Callibaetis coloradensis Banks	Northern
	Callibaetis nigritus Banks	Northern
	Dactylobaetis cepheus Traver & Edmunds	Northern
	Paracloeodes abditus Day	Western
Caenidae	*Caenis simulans* McDunnough	Northern
Ephemerellidae	*Attenella delantela* (Mayo)	Western
	Attenella margarita (Needham)	Northern
	Caudatella heterocaudata (McDonnough)	Western
	Caudatella hystrix (Traver)	Western
	Drunella (*Myllonella*) *flavilinea* (McDunnough)	Western
	Drunella (*Drunella*) *spinifera* Needham	Western
	Ephemerella aurivillii Bengtsson	Northern & Western
	Ephemerella infrequens McDunnough	Widespread
	Eurylophella lodi (Mayo)	Western
	Serratella levis (Day)	Western
	Serratella micheneri (Traver)	Western
	Serratella sequoia (Allen & Collins)	Western
	Serratella teresa (Traver)	Western
	Serratella velmae (Allen & Edmunds)	Western
Ephemeridae	*Ephemera simulans* McDunnough	Northern
	Hexagenia limbata (Serville)	Northern
Heptageniidae	*Cinygmula mimus* (Eaton)	Western
	Cinygmula par (Eaton)	Western
	Cinygmula tioga Mayo	Western
	Heptagenia solitaria (McDunnough)	Northern
	Iron albertae (McDunnough)	Widespread
	Iron deceptivus (McDunnough)	Northern
	Iron dulciana (McDunnough)	Western
	Iron lepidus (Traver)	Western
	Ironodes nitidus (Eaton)	Western
	Ironopsis grandis (McDunnough)	Western
	Nixe (*Akkarrion*) *criddlei* (McDunnough)	Northern
	Nixe (*Akkarrion*) *simplicioides* (McDonnough)	Widespread
	Rhithrogena flavianula (McDunnnough)	Western
	Rhithrogena futilus McDunnough	Northern
	Rhithrogena undulata Banks	Northern
Leptophlebiidae	*Choroterpes albiannulatus* McDunnough	Northern
	Choroterpes intermedia McDunnough	Southern
	Paraleptophlebia debilis (Walker)	Northern & Western
	Paraleptophlebia heteronea (McDunnough)	Northern
	Paraleptophlebia memorialis (Eaton)	Widespread
	Paraleptophlebia placeri Mayo	Western
	Traverella albertana (McDunnough)	Widespread
Siphlonuridae	*Ameletus amador* Mayo	Western
	Ameletus validus McDunnough	Western
	Edmundsius agilis Day	Western
	Siphlonurus columbianus McDunnough	Northern

Table 2. Continued.

Family	Species	Area of State
	Siphlonurus occidentalis Eaton	Widespread
	Siphlonurus spectabilis Traver	Western
Tricorythidae	*Leptohyphes apache* Allen	Southern
	Leptohyphes packeri Allen	Southern
	Leptohyphes quercus Allen	Southern

Mesoamerican Subdivision

This subdivision includes two patterns the "Mesoamerican" and the "Widespread Mesoamerican," the latter may include species that eventually will be found in Nevada.

Widespread Mesoamerican Distribution Pattern.—This (Fig. 2) includes nine species that are distributed from tropical Mexico and Central America to the southern United States. Two of these, the boreal *Choroterpes intermedia* McDunnough and the austral *Leptohyphes packeri* Allen, are expected to be found, eventually, in Nevada. The former species is known from western Arizona to Mexico. The latter is the most widely distributed species in the Americas, from Honduras to southwestern Arizona. The other species that are distributed in this pattern do not occur north of southern Arizona and New Mexico and have not been found north of their presently known distributional limits.

Conclusions

The mayfly fauna of Nevada (Table 1) presently includes 16 species in 12 genera. We postulate that an additional 20 genera and 58 species will be found in the state (Table 2) based upon biogeographic assessments of surrounding states. The order of listing in Tables 1 and 2 are alphabetical, not phylogenetic. The total potential number of genera and species should be 32 and 74, respectively. We further hypothesize that 26 species will be found in western Nevada; 15 in northern Nevada; four in the southern part of the state; two in the north and west; and 11 species will be found to be widespread. Future collections are expected to corroborate these predictions confirming the use of biogeographic information in assessing the state's fauna as a whole, and that of its partitioned regions.

Species of different genera and subgenera can be expected to be found in the following habitats: *Ameletus, Heptagenia, Iron,* and *Rhithrogena* in small rapid streams; *Edmundsius* in slow flowing, shallow streams; *Caenis, Callibaetis,* and *Siphlonurus* in lentic situations; *Attenella, Choroterpes, Ephemerella, Caudatella, Drunella, Eurylophella, Serratella, Ephemera,* and *Hexagenia* in a variety of lotic and lentic habitats; *Dactylobaetis, Cinygmula, Paraleptophlebia,* and *Leptohyphes* in a variety of lotic habitats; *Paracloeodes* in large streams; *Baetis* species in streams that range from slow flowing to torrential. Detailed habitat descriptions can be found in Edmunds et al. (1976) and Edmunds (1984).

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